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INCIDENCE OF INSECT PESTS IN GROUNDNUT (*Arachis hypogaea*) FIELDS AND STORAGE IN KARACHUONYO AND NYAKACH CONSTITUENCIES OF WESTERN KENYA

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ABSTRACT

Groundnut is a popular grain legume crop, and an important cash crop in Western Kenya. However, farmers are facing various production constraints leading to low yields. Yearly, statistical reports by the Agriculture and Food Authority (AFA), Nuts and Oils Crops Directorate show a consistent decline in groundnut production in the potential. Lack of quality planting seeds, and pest infestation during growth and storage have been cited as major problems. Studies on the pests of the groundnut crop in the regions are still scarce. The study's objective was to identify the key insect pests associated with the cultivation and storage of groundnuts in selected parts of the Western region of Kenya. The study was conducted in ten groundnut farms in Nyakach and Karachuonyo constituencies in two seasons, 2021 and 2022. Observation and direct field and storage insect sampling were done in the two regions. The species richness, abundance, and diversity of insects were calculated by analysis of variance (ANOVA) and Shannon Weiner index, respectively. In the present study, a total of 2,714 insect pests from 7 orders, 14 families, and 20 species of field pests and 2,396 individuals from 3 orders, 5 families, and 7 species of storage pests were recorded. This study shows that *Empoasca kerri,* was the most dominant field pest with a mean average of 344, followed by *Aproaerema modicella* (230), *Frankliniella schultzei* (136), *Aphis craccivora* (208), *Microtermes* sp. (96), *Scirtothrips dorsali* (64), *Elasmolomus sordidus* (69), *Spodoptera litura* (56) and *Parastictococcus multispinosus* (30), while storage pests were *Liposcelis decolor* (438), *Tribolium castaneum* (438), *Plodia interpunctella* (146), *Cryptolestes minutus* (137) and *Ephestia cautella* (30). These pests were causing physical damage to the groundnut plants, seeds and pods, leading to deterioration in the weight, quality, vigor, and reduction in the germination, thus leading to the loss of yield and market value. The study recommends further investigation of the actual damage potential of insect pests on groundnuts and the appropriate management strategies.

Key words: Groundnut, insect pests, *Empoasca kerri*, *Aproaerema modicella, Liposcelis decolor*

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INTRODUCTION

Groundnut is an important food crop worldwide, contributing significantly to food security and poverty reduction [1]. It is a major source of oilseed legumes and contains essential nutrients such as calcium, phosphorus, and vitamins. It is ranked 13th most important food crop and 4th in the oilseed crop [1, 2]. Groundnuts help control protein and energy malnutrition in developing countries as it contains 25-34% protein, and 44-56% oil [3]. In Kenya, groundnut farming is a significant staple crop, grown mainly by small-scale farmers both as subsistence and as a source of income on the sale of its seeds and peanut-based products [5, 6]. In Western Kenya, Kisumu and Homabay counties are the major groundnut-producing counties [5, 6, 7]. Its production is mainly carried out by smallholder farmers under rain-fed conditions with limited inputs [4, 5, 7, 9]. However, groundnut farming in Kenya faces significant challenges due to insect pests and diseases, leading to low yields [5, 8, 9]. The above-ground pests, directly damage the groundnut foliage, reducing the yields, root and pod feeders attack the groundnuts at all stages of development, causing plant death and yield losses [10, 11].

The primary above-ground insect pests being sucking pests/sap feeders include leaf hoppers (*Empoasca kerri*), aphids (*Aphis craccivora*), thrips (*Scirtothrip dorsalis*, *Frankliniella schultzei, Frankliniella fusca*), spittle bug (*Locris* sp.), stink bug (*Nezara virudula*) [11, 12, 13]. These species directly damage groundnut foliage by sucking liquid from young leaves or branches and then disrupting plant photosynthesis and metabolism resulting in weak, withered plants and reduced yields. Other devastating above-ground pests are foliage feeders/defoliators and leaf miners/rollers, including leaf miners (*Aproaerema modicella),* red-headed hairy caterpillar (*Amsacta albistriga*), tobacco caterpillar (*Spodoptera litura)*, African bollworm (*Heliothis* sp.) and gram pod borer caterpillar (*Helicoverpa armigera*) [13, 14, 15, 16]. They damage groundnut plants by leaf consumption reducing flowering and fruiting. In all African countries where groundnut leaf miners have been reported, the pest has reached epidemic form and severe yield losses have been observed [14, 15, 16].

Root and pod feeders are below-ground pests that attack groundnuts at all stages of development. They include termites (*Microtermes* sp*, Odontotermes* sp.) root mealybugs *(Parastictococcus multispinosus)*, pod sucking bugs (*Elasmolomus sordidus*), root grubs (*Holotrichia serrata*), white root grub (*Schizanycha* sp, *Schyzonycha fusca, Schyzomychz Africana),* millipede (*Peridontopyge pervillata*), and earwigs (*Anisolabis* sp.) [17, 18, 19]. They attack young crops and feed to roots causing damage to the tap roots and leading to sudden wilt, and gradual death of the plant, while at mature stages, others penetrate the pods, lowering the commercial value of the pods [18, 19]. Some kernels will be damaged by secondary

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infection, soil fungi with species of the *Aspergillus flavus* group, leading to the formation of aflatoxin in seeds before harvesting and during storage [19].

In addition, storage insect pests cause serious damage and significant losses in stored groundnut crops. About 1.3 billion tons of food are lost globally, before reaching the consumer due to post-harvest losses and quality deterioration [20, 21, 22]. The damage and losses are estimated to be 20% annually worldwide [23, 24, 25]. The Coleoptera, Lepidoptera, Hemiptera, and Psocoptera are types of the storage insect pest that attack stored groundnuts mostly consisting of beetles (*Tribolium castaneum, Cryptolestes minutus,* and *Sitophilus oryza),* moths (*Ephestia cautella, Plodia interpunctella, Corcyra cephalonica*) and booklice (*Liposcelius decolor*) [20, 21, 22, 25]. It is important to address these groundnut field and storage pests in order to provide practical recommendations and best practices for scaling up productivity and reducing losses. The present study was carried out on groundnut farms and store houses at Karachuonyo and Nyakach constituency in Homabay and Kisumu counties, respectively. These are regions in Kenya, where groundnuts are majorly grown during the short and long rainy seasons. They are significant areas for groundnut production in Kenya. Groundnuts are a staple crop after maize due to their suitability for the soil type and ability to withstand the climatic conditions in these areas. The study aimed to determine the incidence of field and storage insect pests affecting groundnuts in western Kenya.

MATERIALS AND METHODS

Field Location

The study was carried out over six months, from March to August 2020 and 2021, being seasonal crops grown at the onset of rains in, the same duration and period, in 12 farms in groundnut production areas in Western Kenya. The chosen sites were Karachuonyo constituency in Homa-Bay County (with longitudes 34˚ 27' E and latitudes 0˚ 40' N) and Nyakach constituency in Kisumu County (with longitudes 34˚ 46' E and latitudes 0˚53' S), which had similar agro-climatic conditions. The average annual rainfall in these areas is 218.04 mm and 1359 mm while the average annual temperature is 21.8ºC and 23.93ºC in Homabay and Kisumu counties, respectively.

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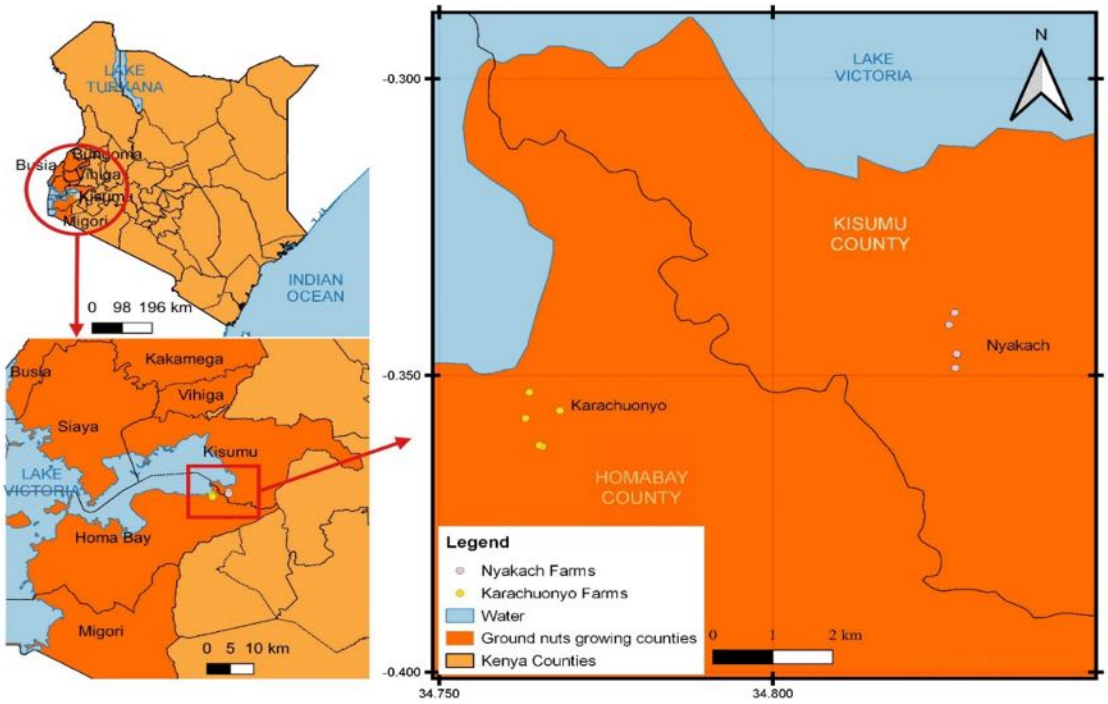

Fig. 1: The study sites are in Karachuonyo and Nyakach in Homabay and Kisumu counties, respectively. (Top left) Map of Kenya counties showing the study areas; (Bottom left) Map of Kenya showing the locations of groundnut growing regions in Kenya within Lake Victoria basin (in brick orange), (Right side) Homabay and Kisumu counties showing the enclosed study areas, the sampling points

Experimental design

The experiment was conducted in a completely randomized block design, which included six groundnut varieties and twelve farms. There were three replications per farm. Six peanut varieties were sourced from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Malawi. The varieties were CG7, CG9, CG12, 12991, and ICGV-SM 90704, of which five were improved groundnut varieties. Control (Homa Bay Local) locally sourced varieties were also planted. Except for the four control farms, farmyard manure was applied to each farm 8 farms at the rate of 7 tons per acre. A single seed per hole was planted at a depth of 5cm, and a spacing of 50 x 10 cm under rain-fed conditions. All the recommended agricultural practices for groundnut farming, including ploughing, row planting, molding, and two rounds of manual weeding, were applied equally to each farm. However, only the experimental farms received agronomic interventions such as farm yard manure application and spraying for pests and diseases, while the control farms did not (where local recommended cultural practices for groundnut farming in the regions were followed, including ploughing, row planting of Homa Bay local

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varieties, molding, and manual weeding twice). To manage fungal diseases and above-ground insect pests, Ridomil 50g and Duduthrin 65 ml in 20 litres were used, respectively. The recommended application of Duduthrin and Ridomil was followed as per the product manual. 50g of Ridomil gold (4% w/w metalaxyl-M and 64% w/w mancozeb) from Syngenta and Duduthrin 1.75 EC (Twiga chemicals) contact insecticide (65 Ml in 20 L of water) were mixed and sprayed on the groundnut in four sessions to protect against diseases, insects and other pests. The first application took place four weeks after groundnut germination, with a repeat application a week later. The second application was carried out at eight weeks during the flowering stage, followed by a repeat after a week. Most pests appeared in the crop during the vegetative and flowering stages. Spraying was conducted early in the morning between 6:30 to 8:00 a.m. or late in the evening between 5:30 and 7:00 p.m.

Field insect pest sampling

Insects were collected during groundnuts growth, harvesting, and storage for the two long rain seasons in 2020 and 2021. The samples were collected between April and August for growth and harvesting, while for storage pests' samples were collected in December, March, and June from the pods and seeds in storage bags.To collect insects from crop foliage (leaves), soil stems, and roots, various techniques such as sweep netting, pan trapping, pitfall trapping, and hand collecting were used. A sweep net with a 30cm diameter was used to collect crawling and flying insects on the groundnut plant. The insect's collection process was carried out on several farms using a systematic random sampling technique. The process was divided into twenty rounds, with each round lasting for an hour. The insect was collected using spacemen bottles and preserved in 70% ethanol. To capture the insects, pan traps were set up by placing a plastic bowl as a trap on two lines transect that were established across the farms. A total of 20 pan traps were set up at an interval of 50cm along these transects. The pan traps were filled halfway with soapy tap water to kill the captured insects and were left out for 9 hours. The collected insects were then transferred to spacemen bottles and preserved in 70% ethanol.

In the study, a plastic glass was used as a pitfall trap. Twenty small holes, each 10cm deep were dug into the ground in the line transects. A total of 20 pitfall traps were placed in these holes and the rim was left flush with the ground surface. The traps were filled halfway with soapy tap water to kill any crawling insects trapped or captured, and the traps were left for 48 hours. All the insects captured in the traps were collected in a bottle and preserved in 70% ethanol. In addition to the pitfall traps, manual searching, and hand collection were conducted for three hours in each farm. This involved actively searching for insects on the ground, inside the soil, in leaf litter, on foliage, stems, roots, kernels, pods, and seeds of the groundnut. Forceps and a camel brush were used for collection.

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The collected insects were taken to the laboratory for sorting, pinning, drying, and identification. Only the hard-bodied insects were pinned into wooden drawers and dried in the oven at 50º C while the soft-bodied ones were kept in 70% ethanol. To identify the insect, their morphological characteristics were observed under a stereo microscope guided by literature, and online taxonomic references according to Wightman and Amin [26]. The identification process was cross-checked with archived reference collections at the Invertebrates, Zoological Department of the National Museums of Kenya with consultation and guidance from the Invertebrates Expertise in the Laboratory.

Sampling of Storage insect pest

During the groundnut storage study, 8 kg of dry groundnut was collected from 8 experimental farms and 4 control farms. The groundnuts were sorted carefully to remove any damaged kernels or signs of pests' activity. Only the undamaged groundnuts were placed in PICS bags and polypropylene bags. Both types of bags were used for storage and monitoring for 24 weeks (six months). Direct observation was used to detect the presence and level of pests' infestation. After 3 months of storage, each storage bag was opened, groundnuts carefully poured onto clean white polypropylene bags, and inspected for insect infestation. Any larvae and adult pest found were collected using forceps and camel brush, and then preserved in 70% ethanol and moths were kept in insect envelopes. This process was repeated every 3 weeks for the duration of the study.

An additional experiment was conducted in the Invertebrates Laboratory. Two (2) kg of visibly clean kernels were selected from the harvest and placed in a 4kg plastic jar with a tightly sealed lid. The jar was opened every 3 weeks to examine for the presences of insects. Adult insects, larvae, cocoons, and pupa were collected using forceps and preserved in 70% ethanol and moths in insect envelopes. This process was repeated until the 16th week. They were later identified using a similar method indicated above. Data on the population of different insect pests was recorded during the flowering stage, at harvesting, and during storage was analyzed.

Data Analysis

Statistical analyses were done using R version 4.2.0 with 95% accuracy. Two-way Analysis of variance (ANOVA) was used to determine any significant differences in abundance and richness, while the Shannon index compared the diversity of groundnut insect pests.

RESULTS AND DISCUSSION

In the present study, a total of 2,714 insects from 7 orders, 14 families, and 20 species of field pests were recorded. This study shows that *Empoasca kerri,* was the most dominant field pest with a mean average of 344, followed by *Aproaerema*

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modicella (230), *Frankliniella schultzei* (136), *Aphis craccivora* (208), *Microtermes* sp. (96), *Scirtothrips dorsali,* (64) *Elasmolomus sordidus* (69), *Spodoptera litura* (56), *Parastictococcus multispinosus* (30) as indicated in Table 1. There were various species found in groundnut farms in the growing regions, indicating the presence of a group of insect pests. These pests include those that feed on sap, defoliate, or feed on foliage, as well as those that feed on roots and pods. This poses a significant threat to groundnut production in the Western regions of Kenya, leading to yield losses. The sap feeders, leaf hoppers (*Empoasca kerri),* aphids *(Aphis craccivora,)*, and thrips (*Scirtothrip dorsalis* and *Frankliniella schultzei*) followed by defoliators which are leaf rollers (*Aproaerema modicella*) were the most predominant, widespread, and most abundant in the two seasons as indicated in Table 1. They are similar species reported in other studies [11, 13, 14].

Empoasca kerri, *Aphis craccivora, Scirtothrip dorsalis,* and *Frankliniella schultze* were the most destructive sap suckers found on groundnut crops throughout Africa [11, 13, 18]. The sap suckers inject salivary fluids into plants and these secretions kill plant cells, they excrete the excess sugar water as honeydew, which supports the growth of sooty mold. Thrips also transmit peanut bud necrosis and stem necrosis viruses, which were noticed on the field and they can cause widespread yield loss when not managed on time [12]. Groundnut leaf miners' larvae were the most destructive pest recorded during this field study causing serious crop mines and webbing almost all leaflets together. In all African countries where this groundnut leaf miner has been found, the pest has reached epidemic level and severe yield losses have been observed on groundnut [14]. Other devastating above ground pests reported are foliage feeders' tobacco caterpillars (*Spodoptera litura)*, and gram pod borer caterpillars (*Helicoverpa armigera*) (Table 1). They are crucial pests threatening the production of groundnuts in Western Kenya and other African countries [11, 18].

Termites *(Microtermes* sp.), peanut trash bugs (*Elasmolomus sordidus)* and mealybugs *(Parastictococcus multispinosus),* were among the dominant root and pod feeder species recorded in the study regions (Table 1). They were attacking young crops and feeding on roots causing wilting and death of young plants, at mature stages, feeding on pods causing yield losses [17]. *Microtermes* sp. was the most abundant and widely distributed in both seasons with a mean average of 96 followed by peanut trash bug (69) and mealy bug (31) as indicated in Table 1. Termites were found to be the most destructive pests in the underground region. In the second season, the population of termites was significantly higher at 23.32%, compared to only 1.49% in the first season. This increase in termites' activity and destruction during the second season, could be attributed to the climatic conditions experienced in the country in the year 2022 [27, 28]. The reduction in rainfall led to

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a decrease in soil moisture levels, which impacted the growth of crops. Consequently, they have become more susceptible to termite damage, as termites tend to cause more harm during dry periods or droughts compared to the wet season [29]. In other studies, genera *Microtermes* and *Odontotermes*, are reported to produce the majority of crop damage, their infestation may render the pods more susceptible to infection by *Aspergillis flavus* group, and to subsequent aflatoxin contamination [12, 30]. A higher population of root *Parastictococcus multispinosus* was observed in the first season. They were feeding on groundnut basal parts and roots in the field, causing serious damage to the roots of groundnut. The infested plants showed leaf yellowing and wilting, that marked growth retardation.

Other underground pests encountered at relatively lower numbers were rove beetle (*Staphylinus* sp.), earwigs (*Anisolabis* sp.), and millipede (*Peridontopyge pervillata*) (Table 1). Their low occurrence may indicate they are minor pests to groundnuts in these regions. However, they were similar species that have been reported to affect groundnuts in the semi-arid tropics [18, 31].

In the present study, diverse pests were present in the first season and the diversity and population decreased in the second season as indicated in Table 2. The pest species highest richness (7.00) and abundance (123.6) were recorded in the first season with a significance difference of $p = 0.009$ (Table 2). The incidence of higher abundance in the first season could be attributed to a lack of intercropping or mixed planting of different crops or varieties that have been traditional agricultural practices that have long been used for preventing harmful pests' infestation [32]. This fact has been confirmed because farmers in the study areas were practicing monocropping of groundnut on their farms. During the study, a total of twenty insect species were recorded. Season one had a higher population with an abundance of 2,028 compared to season two which had 695 as indicated by species accumulation curves shown in Figure 1. There was no significant difference in the mean richness of pests between the two seasons, recording 7.00 and 5.58 in seasons one and two respectively ($p = 0.143$).

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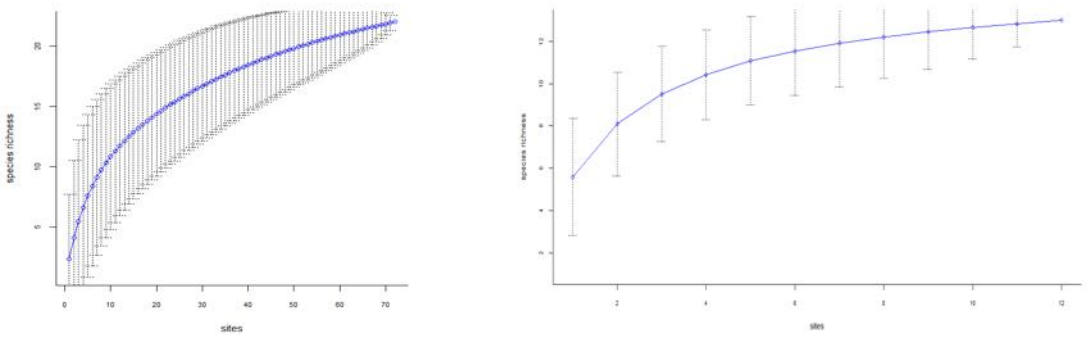

Season 1 Season 2

Figure 2: The abundance of insect pest species recorded in different farms in seasons one and two

The findings from mean abundance recorded between season one 123.6 and season two 57.9 are supported by Ghosh [33] and Harish *et al.* [19] who reported that the pest-management concept is based on integrated pest management that reduces the status of pests to tolerable levels for enhanced crop productivity.

The most diverse destructive insect stages recorded in all farms were adults and larvae. The diversity of adult pests was high with H'= 2.18, followed by larvae H'= 0.54 while the least diverse insect stage observed was Nymph H'=0.39 and pupa H'=0.05. However, adults and larvae were equally abundant in all the farms (Figure 2).

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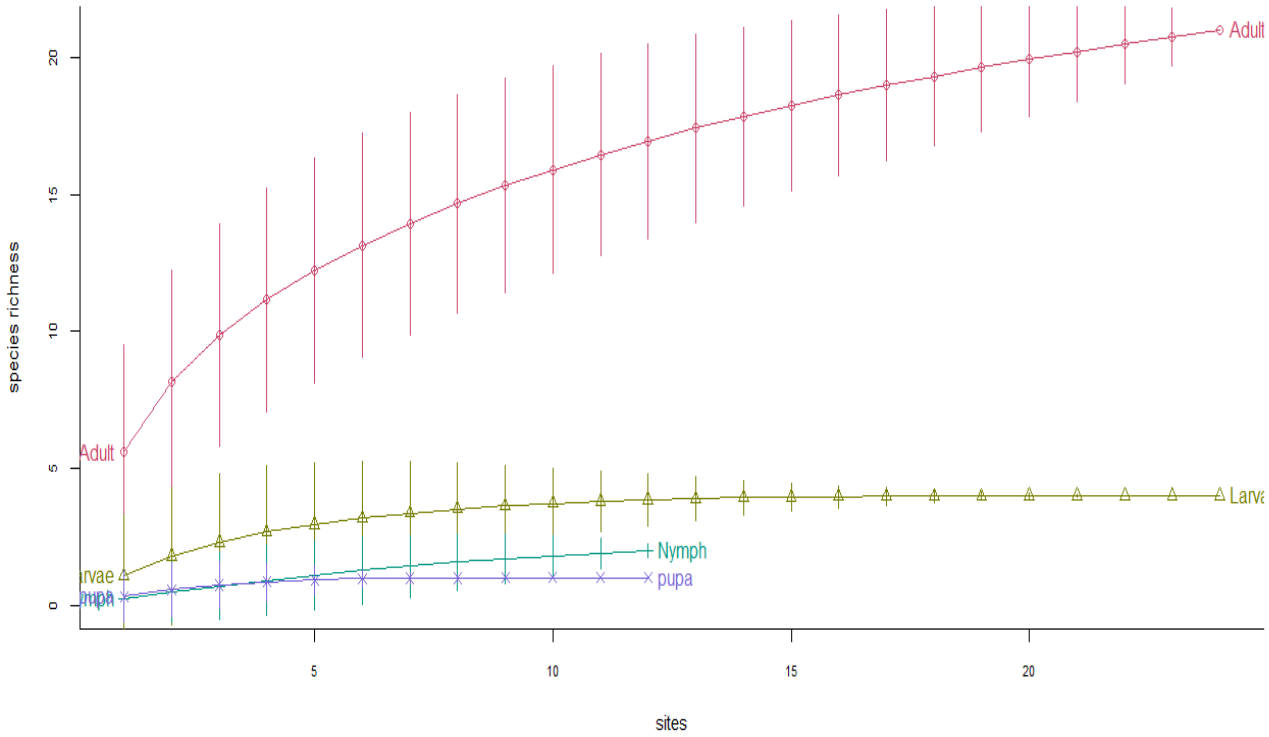

Figure 3: The abundance of different stages of insect pests attacking groundnuts in farms in Karachuonyo and Nyakach Constituency, Kenya

All farms were infested with pests, but some had a higher abundance than others, as shown in Figure 3 below. In terms of seasons and farm management, unmanaged farms had the highest number of pests as compared to managed farms (Figure 3).

In season one, 95% of the farms recorded a high population of pests with a greater diversity compared to season two. The study showed that the mean population of insect pests in control farms was higher than in managed farms. This supports using management options applied in the eight experimental farms as a beneficial approach. An overlapping population of diverse pest species continuously attacked the crops.

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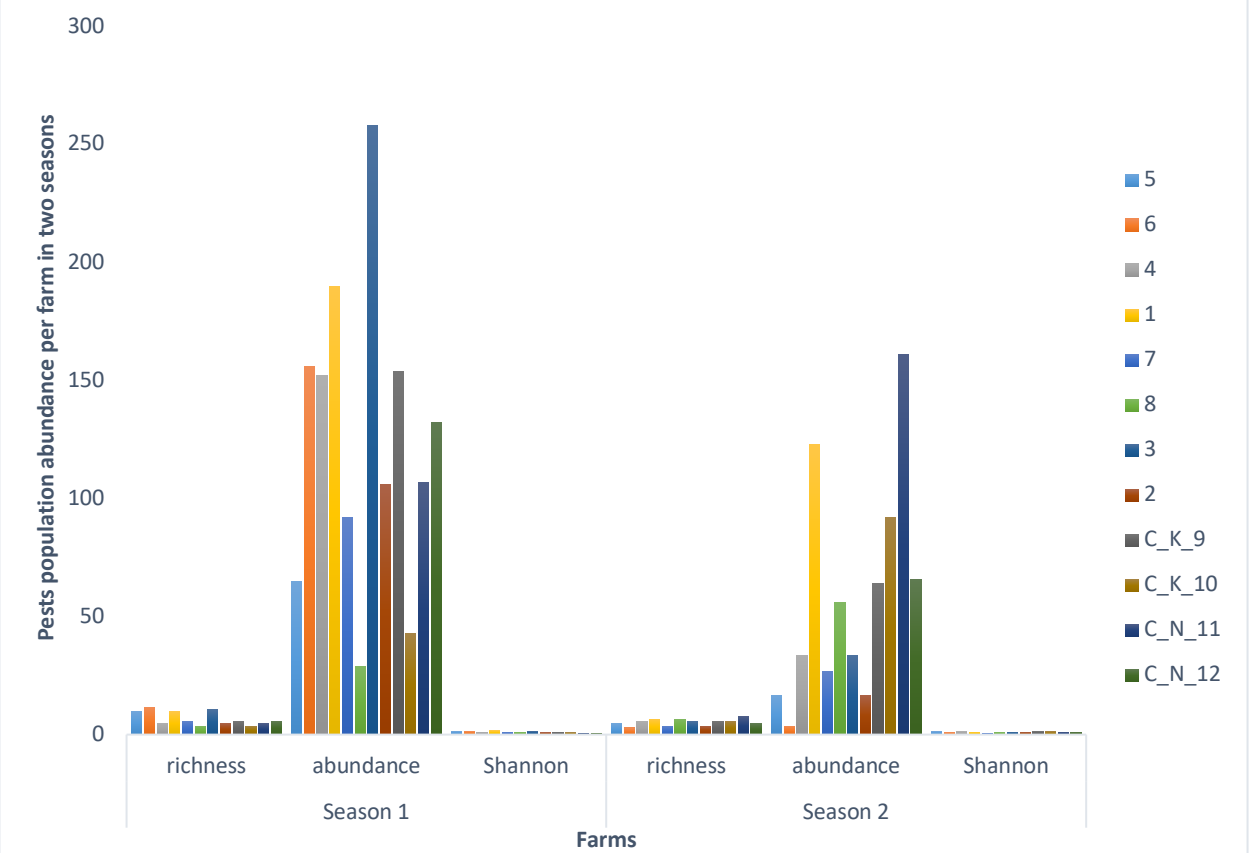

** Numbers 1 to 12 are farms while C_K control Karachuonyo and C_N control Nyakach*

Figure 4: Incidence and diversity of groundnut pests in experimental and controlled farms of groundnut in the study area in Nyakach and Karachuonyo Constituency, Kenya

Apart from field pests, groundnuts were attacked by storage insect pests. Several groundnut storage pest species were present in the stored groundnuts. In the present study, groundnut pods or seeds were infested by several stored grain pests including booklouse (*Liposcelis decolor),* red flour beetle (*Tribolium castaneum),* flat grain beetle *(Cryptolestes minutus),* Indian meal moth *(Plodia interpunctella)* almond moth *(Ephestia cautella),* and rice moth (*Corcyra cephalonica*). They were similar to the major storage pests of groundnuts recorded globally [21, 34].

A total of three orders, five families, and eight insect species of groundnut storage were isolated in PICS and Polypropylene bags. *Liposcelius decolor* (36.4%) and *Tribolium castaneum* (36.4%) were the most abundant insect species followed by *Plodia interpunctella* (12.1%), *Cryptolestes minutus* (11.3%), *Ephestia cautella* (2.5%), *Corcyra cephalonica* (0.8%), and *Sitophilus oryzae* (0.00%) in the storage bags (Table 3). Groundnuts are globally affected by insect pests, particularly those species that are highly abundant and destructive [34, 35, 36].

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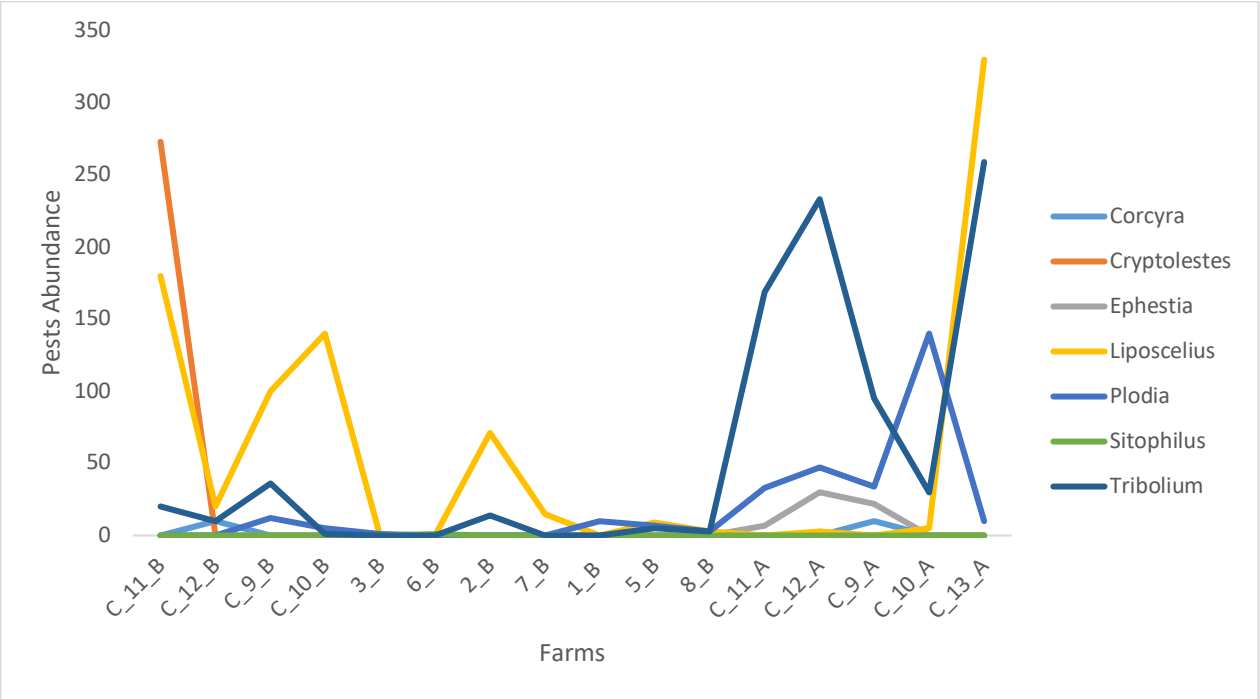
According to the findings, a total of 2,264 individuals were found to be infesting groundnuts harvested from the control farms, while only 142 were recorded from the experimental farms in the study area (Figure 4). The current survey revealed that insect infestation and densities were significantly higher in groundnuts from control farms as compared to managed farms. It supports the finding that stored product pests gain access to the grain storage from the standing crop in the field at various stages to fulfill their food and shelter requirements resulting in losses [34, 35]. It was possible to notice that storage losses were highest in the groundnuts from the control farms. Some insect pests initiate damage at the ripening stage of crops and continue during storage [34, 35].



** C_represent Control farm; numbers 1-13 are farms, B and A represent season two and one, respectively*

Figure 5: Occurrence of storage pests in stored groundnut from different farms within groundnut growing regions in Karachuonyo and Nyakach Constituency, Kenya

The study found that storage pests pose a significant problem for groundnuts in the region, with the most common pests being the red flour beetle (*Tribolium castaneum)*, booklouse (*Liposcelis decolor),* Indian meal moth *(Plodia interpunctella),* and Flat grain beetles *(Cryptolestes minutus)* as indicated in Figure 4. The existence of storage pests in groundnuts has both direct and indirect impacts on human health [21, 34, 40]. The most common direct effect is the contamination of food with arthropod fragments and other related contaminants, which can be allergenic or even carcinogenic [34, 35, 36]. The most important indirect effect is

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their presence which can change the storage microenvironment, making durable products suitable for the rapid development of fungi and other microorganisms [34, 35, 36].

The red flour beetle *(Tribolium castaneum)* has been identified as a major storage pest of groundnuts in a recent study [36, 38, 39]. This beetle is a common pest of stored products and can be found in various commodities worldwide [36, 38, 39]. Due to their rapid growth rate and long lifespan, adult females of this beetle maintain high rates of egg-laying, which can result in serious economic losses if not properly controlled in storage facilities [38, 39]. Studies have shown that this beetle is likely to first colonize a new stock and therefore, it is important to implement effective pest management strategies to prevent infestations [38, 39]. Booklice *(Liposcelis decolor)* are considered serious storage pests and require management due to their high resistance or tolerance to heat treatment in grain storage systems [40, 41]. They are a new risk to global food security and safety. They are significant worldwide pests of stored products and the key storage pests in Australia that are difficult to control with the registered grain protectants and are increasingly being reported as pests of stored products in other countries [40, 41]. Research has shown that certain species survive harsh conditions, including food scarcity, for extended periods [34, 40, 41]. In addition, some species are mostly parthenogenic, thus, all eggs develop into females, leading to a rapid population increase. These findings are supported by studies [34, 40, 42]. The larvae of the Indian meal moth *(Plodia interpunctella)* are known to be the most economically significant pests causing damage to several stored products such as groundnuts, maize, rice, and sugar cane globally [34, 35, 3]. They cause a considerable economic impact on groundnut production by causing direct quantity and quality losses. The larvae produce silk, which webs the groundnut particles together, and excreta (frass) creates an unpleasant odor in infested groundnut [43].

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The present study has confirmed the existence of various field and storage insect pests infesting groundnut crops in Kenya. The results show that insect pests are a significant threat to groundnut production in Kenya. These pests were widespread, frequently occurring, and abundant, indicating that they are major threats to groundnut production in the country. The findings underscore the need for effective pest management strategies to reduce the impact on groundnut yields, requiring a coordinated effort between farmers, researchers, and policymakers. To improve crop management practices, promote integrated pest management techniques, and encourage the adoption of resistant crop varieties. By doing so, it will be possible to improve the sustainability and productivity of groundnut farming in Kenya, while reducing the economic losses associated with pest infestation. It also highlights the

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need for farmers and extension officers to be aware of the incidence Awareness of pests' incidence, practical recommendations, and best practices in groundnut fields and storage areas are crucial to establishing a knowledge base on groundnut pests and for increasing productivity and reducing losses. Understanding insect pests will assist county government and farmers in selecting the appropriate management options to control groundnut insect pests, taking into account the variety of insect species infesting groundnut in the area. To create effective and acceptable pest management strategies, it is important to have detailed information about the pest complex essential to prioritize research efforts and address food security. This knowledge can help the Ministry of Agriculture and researchers prioritize their research efforts to address food security. To ensure the international contribution of groundnuts to food security and poverty reduction, continued research and implementation of management strategies are crucial in Kenya.

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Conflict of Interest

The authors declare no conflict of interest. The authors are responsible for the content and writing of the paper alone.

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Table 1: Insect pests' abundance and richness in 2020 and 2021 in groundnut-producing farms in Nyakach and Karachuonyo constituency in Kenya

Order	Family	Genus/Species	Season 1 Abundance	Season 2 Abundance	Mean Average
Hemiptera	Cicadellidae	*Empoasca kerri*	562 (27.84)	126 (18.13)	344
Lepidoptera	Gelechiidae	*Aproaerema modicella*	452 (22.39)	8 (1.15)	230
Hemiptera	Aphididae	*Aphis craccivora*	233 (11.54)	183 (26.33)	203
Thysanoptera	Thripidae	*Frankliniella schultzei*	227 (11.24)	45 (6.47)	136
Isoptera	Termitidae	*Microtermes* sp.	30 (1.49)	162 (23.31)	96
Hemiptera	Lygaeidae	*Elasmolomus sordidus*	92 (4.56)	46 (6.62)	69
Coleoptera	Tenebrionidae	*Lagria villosa*	0 (0.00)	44 (6.33)	22
Lepidoptera	Noctuidae	*Spodoptera litura*	89 (4.41)	26 (3.74)	57.5
Thysanoptera	Thripidae	*Scirtothrips dorsali*	128 (6.34)	0 (0.00)	64
Hemiptera	Stictococcidae	*Parastictococcus multispinosus*	61 (3.02)	0 (0.00)	30.5
Coleoptera	Tenebrionidae	*Staphylinus* sp	0 (0.00)	25 (3.60)	12.5
Hemiptera	Cercopidae	*Locris* sp.	22 (1.09)	14 (2.01)	18
Lepidoptera	Noctuidae	*Helicoverpa armigera*	36 (1.78)	10 (1.44)	23
Dermaptera	Anisolabididae	*Anisolabis stalli*	32 (1.58)	0 (0.00)	16
Hemiptera	Pentatomidae	*Nezara viridula*	28 (1.39)	3 (0.43)	15.1
Hemiptera	Cicadellidae	*Ptyelus* sp.	4 (1.20)	3 (0.43)	3.5
Hemiptera	Cicadellidae	*Platypleura* sp	20 (0.99)	0 (0.00)	10
Spirostreptida	Odontopygidae	*Peridontopyge* sp.	1 (0.05)	0 (0.00)	0.5
Lepidoptera	Noctuidae	*Heliothis* sp.	2 (0.10)	0 (0.00)	1

*Relative proportion (%) of insect pests

Table 2: ANOVA table showing the variation of insect pests' abundance and richness with the season in farms in Nyakach and Karachuonyo constituency, Kenya

	Season 1			Season 2		
Variable	Mean	Std. Error of Mean	Sig. P-value	Mean	Std Error of Mean	Sig. P-value
Abundance	123.67	18.624	0.009	57.92	13.620	0.009
Richness	7.00	0.835	0.143	5.58	0.417	0.143

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Table 3: The taxonomic position and status insect pests identified from stored groundnut of the study area in Nyakach and Karachuonyo constituencies, Kenya

Family	Genus	Species	Common Name	Abundance	Proportion
Liposcelididae	*Liposcelis*	*decolor*	Booklice	876	36.4
Tenebrionidae	*Tribolium*	*castaneum*	Red Flour Beetle	876	36.4
Pyralidae	*Plodia*	*interpunctella*	Indianmeal moth	291	12.1
Cucujidae	*Cryptolestes*	*minutus*	Flat grain beetles	273	11.3
Pyralidae	*Ephestia*	*cautella*	Almond moth	59	2.5
Pyralidae	*Corcyra*	*cephalonica*	Rice moth	20	0.8
Curculionidae	*Sitophilus*	*oryzae*	Lesser grain weevil	1	0

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